Paper Folding Pinwheels

Objective: Apply geometric vocabulary and identify geometric shapes while paper folding.

Materials: 8 squares of brightly colored paper per participant
One rectangular sheet of paper per participant

Procedures:

1. Ask participants to make the largest square possible from the rectangular sheet paper. Some will have difficulty with this, but there will be someone that will fold the shorter edge onto the longer side. Ask someone who discovered the largest possible square to explain how they know it is the largest possible square.

2. Have participants get 8 squares. The best combinations are 4 sheets in two complementary colors, or 2 sheets of 4 different colors.

The following steps will be repeated an additional 7 times. Instruct participants to complete all folds in a particular step before moving on the next.

3. Have students fold each sheet in half. What is this fold called? (line of symmetry) Fold sheet in half the opposite direction. (see Figure 1) What is this fold called? (line of symmetry) When you open the paper up, what do you see? (4 smaller congruent squares) What fractional part of the original square is each of the smaller squares? ($\frac{1}{4}$) What kind of angle is formed at the intersection of the two fold lines? (90° or right angle) How many lines of symmetry does a square have? (4) What are the other 2? (the diagonals) **Do not** fold to illustrate, or use the sheet of paper from step one to illustrate all four lines of symmetry. (See notes.)

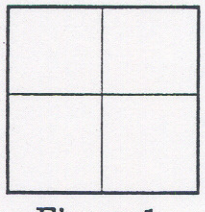


Figure 1

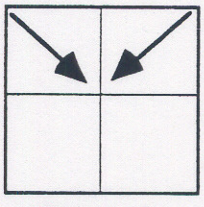


Figure 2

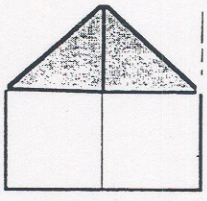


Figure 3

4. Place the square on the table in front of you with the lines of symmetry horizontal and vertical and the folds opening toward you instead of the

table. Fold the upper left-hand corner down to the intersection of the folds. What is this shape called? (pentagon) What fractional part is folded down? ($\frac{1}{8}$) How do you know? Repeat with the upper right-hand corner. What is this shape called? (pentagon) What fractional part is now folded down? ($\frac{1}{4}$) See Figure 3. What is the measure of the angle formed by the two folds? (90°; 45° + 45° each little triangle is an isosceles right triangle) How do you know? There is an angle formed when the upper left corner was folded to the intersection of the first two folds. What is it called? (an obtuse angle) What is its measure? (135°; 90° + 45°) How do you know?

5. Fold the right edge over to the left edge. Do all edges match? (yes) What does this mean? (The fold is a line of symmetry.) Rotate your paper 90° left (right for left handed people). See figure 5. What shape is this? (trapezoid) Notice that the top edge is a fold. This is very important later. Also notice that you can see the fold line and that line divides the trapezoid into an isosceles right triangle and a square.

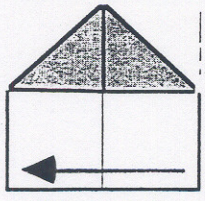


Figure 4

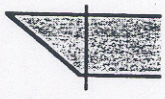


Figure 5

6. With the paper oriented as in Figure 5, fold the upper right corner down to the obtuse angle. See Figure 6. Unfold, turn the paper over and make the same fold again. You have now folded along the same line to the front and to the back. What geometric shape do you have? (parallelogram) What fractional part of the original square is the parallelogram? ($\frac{1}{4}$) Justify your answer.

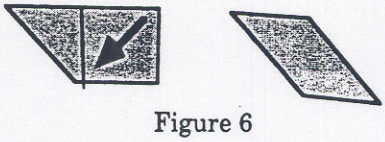


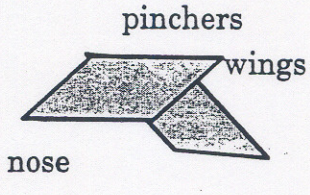
Figure 6

7. Now hold the parallelogram by the acute angle with the left hand. The triangle you folded to the front and back should be free. Open the parallelogram with your right hand, and push the triangle into the parallelogram. In origami, this is called a squish fold.

8. You should now have eight congruent parallelograms. When inspecting the edges of the parallelograms you will find that one edge is made of one fold. Two edges are made of two folds, but one of these edges wants to come "open" (the squish fold from step 7) and the other edge has several single thicknesses. Orient all the parallelograms as in Figure 7 with the folded edge as to "top" the squish folded edge on the right and the bottom is the edge made up of single thicknesses. Students often say the squish fold makes "pinchers" and the acute angle with the single fold is a "nose". This can be helpful in explaining how to assemble. Arrange colors in desired pattern.

9. It is now time to assemble the pinwheel. Holding the parallelogram by the single edged "nose" in the left hand, place the "nose of another parallelogram in the "pinchers" of the first. Make the edges even. There will be "wings" from the parallelogram in your left hand. Fold these into the "pinchers of the second parallelogram.

Figure 7



10. Rotate counter-clockwise and repeat. Make sure that when you put the nose into the pinchers that it does not go under one of the wings that have been folded into the pinchers. The final step is to join the first with the last. The steps are the same. What shape do you have? (octagon) Now before going any further, look at the outer edge of the octagon and make sure no noses are tucked under wings. Once you verify this, begin tapping on an edge. The sides will begin to move and when the inner hole is closed, you have a pinwheel.

11. Now move the sides of the pinwheel to make the inner edges form different geometric shapes. Can you make a square? rectangle? parallelogram? hexagon? What other polygons can you make?

Notes:

1. Slick paper from magazines works well. Sometimes it is hard to coordinate colors in the pictures.

2. Squares made from half sheets of paper make a nice size pinwheel. Save the part you cut off; participants will use the scraps to make tiny pinwheels.

3. This activity is found in the November 1995 issue of *Wonderful Ideas* pages 6 and 7 ("The Moveable Octagon") Used by permission.

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